Modelling and Development of Compressed Air Powered Human Exoskeleton Bionic Arm

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***Abstract*: Exoskeleton Bionic Arm (EBA) are used for external support of force, balance, enhancement and mobility assistance. EBA makes the human ability to a different level of enhancement which is used in carrying heavy objects, steady handling of explosive and chemical material and nature and artificial hazards. The major problem faced by present exoskeleton is power consumption due to heavy powered mechanism use in the active exoskeleton it has a limited numbers of moves, less freedom of motion and low degree of angles due to rigid body shape and alinement. In our project we have built air compressed powered human bionic exoskeleton arm (ACPHBE) by using which we can lift an object or weapon weighting up to 25Kg without even feeling it. So we have developed an active bionic exoskeleton arm (ABEA) which we have developed in our house. Due to supportive and less weight frame, powered motors, air muscles and air compressor, the arm which consist handmade pneumatic air muscles (PAM) has more number of movement then active exoskeletons.**

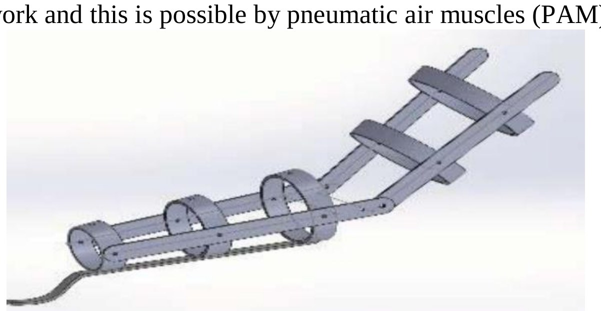
***Keywords*: Heavy objects, Steady handling, Hazards management, number of moves, less freedom of motion, low angle of degrees, Air compressed powered human bionic exoskeleton arm (ACPHBE), active bionic exoskeleton arm (ABEA), handmade pneumatic air muscles (HPAM**

I. INTRODUCTION

1) Air Compressed Pneumatic Muscle Arm (ACPMA):

Effect of research over the exoskeleton has made this evolution over the process of development of exoskeleton systems. ACPMA is an exoskeleton arm which works by pneumatic system ACPMA consist of arm structure which can worn as an external arm which makes the human effort easy and ease their work and this is possible by pneumatic air muscles (PAM) used in (ACPMA)

The designed project is like under the given picture:



The compressed air powered exoskeleton bionic arm using flexible pneumatic air Muscles which acts as the biceps and triceps of the bionic arm where those Muscles helps the arm to achieve the degree of freedom.

2. PNEUMATIC ARTIFICIAL MUSCLES SYSTEM (PAMs):

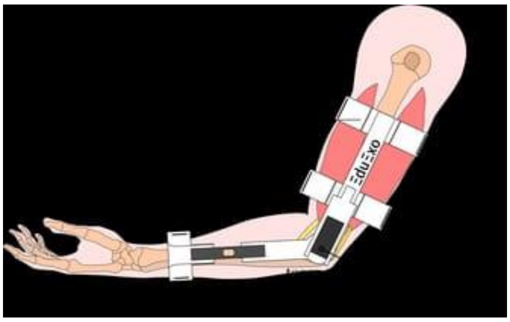
Pneumatic artificial muscles (PAMs) are contractile or extensional devices operated by pressurized air filling a pneumatic bladder. In an approximation of human muscles, PAMs are usually grouped in pairs: one agonist and one antagonist. PAM these air muscles have high force to weight ratio, high power to weight ratio, high powerful and produce perfect accurate motion that any other module can’t provide. The pneumatic muscles are water resistance which can withstand up to several meters underwater. These parameter makes this Air muscles suitable for application in robotics like humanoid and exoskeleton, bio robotics, biomechanics, artificial limb replacement and industry for requirement.

II. MODELLING OF BIONIC ARM

1. DESIGN OF AIR COMPRESSED PNEUMATIC MUSCLE BIONIC ARM

Left and right limb or arm where this ACPMA is worn which consist of 4 Pneumatic air muscles of length 83cm each which inflate when compressed air comes out of the air compressors which get filled inside the air muscles and provide the thrust force required to lifting weight or to do certain tasks. The pneumatic air muscles consists of silicon rubber tube and covered by nylon mesh which acts as the actual human muscles. It expand in a unidirectional way and at the joints to servomotor and rotating balls on the joints to provide the flexibility. The full setup frame is made up of stainless steel and highly safe for real time applications and all other components are mounted on the bionic arm itself.

The pneumatic structure consist an air compressor, solenoid control valve and air muscles which is connected to the frame structure. Batteries are used on board power supply which provide the required power for the Arduino, indicators, EMG sensors or muscles sensors



2. WORKING OF AIR COMPRESSED PNEUMATIC MUSCLES BIONIC ARM (ACPMA):

ACPMA works by the muscles reflex pulse on arm's biceps and triceps where these signals are conducted by the EMG sensors and processed by Arduino and the physical movement is given by the servo motors

3. HARDWARE AND SOFTWARE

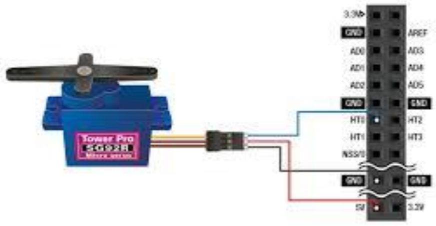
A) ARUDINO:

The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog Input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts. It is also similar to the Arduino Nano and Leonardo. The hardware reference design is distributed under a Creative Commons Attribution Share-Alike 2.5 license and is available on the Arduino website. Layout and production files for some versions of the hardware are also avail**.**

A) SERVO MOTOR

A servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors. Servomotors are not a specific class of motor, although the term servomotor is often used to refer to a motor suitable for use in a closed-loop control system. Servomotors are used in applications such as

Robotics, CNC machinery or automated manufacturing



B) **EMG sensor:**

EMG Sensor, also known as electromyography sensor is one that measures small electrical signals generated by your muscles when you move them

This includes lifting your arm up, clenching your fist, or even the simplest of movements like moving a finger Technical details If you would like to further understand the technical side of things, here’s how your muscles move and its relationship with ECG: The whole process starts off in your brain Neural activity in the motor cortex (part of your brain) signals to the spinal cord The signal is then conveyed to the muscle part via motor neurons Motor neurons innervate the muscle directly, causing the release of Calcium ions within the muscle and ultimately creating a mechanical change This mechanical change involves depolarization (change in electromechanical gradient), which is then detected by EMG sensors. These EMG sensors

III) EXISTING SYSYEMS:

1. **Armour exoskeleton:**
A powered exoskeleton (also known as power armor, powered armor, powered suit, exoframe, hardsuit or exosuit) is a wearable mobile machine that is powered by a system of electric motors, pneumatics, levers, hydraulics, or a combination of technologies that allow for limb movement with increased strength and endurance.
2. **Medical exoskeleton:**
The PHOENIX Medical Exoskeleton is the world's lightest and most advanced exoskeleton designed to help people with mobility disorders to be upright and mobile. In the clinic, at home, and in the workplace Phoenix has successfully enabled many individuals to stand up, walk about, and speak to peers eye-to-eye.
3. **Industrial exoskeleton:**
“Industrial exoskeletons” is the collective name given to mechanical devices worn by workers, whose construction mirrors the structure of operator’s limbs, joints, and muscles, works in tandem with them, and is utilized as a capabilities amplifier, or as a fatigue and strain reducer. Body weight support, lift assistance, load maintenance, positioning correction and body stabilization are common capabilities of industrial exoskeletons.

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V) CONCLUSION:

This paperwork is a guide for a working prototype of a pneumatic muscle exoskeleton using muscle sensor and powered by compressed air which gives the power to lift more than 25 kg without the sense of the lifting. Which as the flexible axes of moment and power conception which makes this experimental exoskeleton unique.